Sticky Situation

Avani Patel, Kamile Berenyte, Phil Bagley,

Bartlett High School

Engineering Design & Development

May 23, 2012

# ABSTRACT

Millions of people walk on sidewalks every day for work, school, shopping, etc. Numerous citizens complain that they see gum on the ground, and especially get frustrated when gum gets stuck to their shoe. Our product, Gum Shield, will protect the average walker from gum getting stuck to the shoe and ruining it. After researching the market and conducting product specific research we made a visually and structurally appealing product. Computer modeling and numerous tests were done to prove the viability and durability of the product. The final product was then tested again to prove that the redesigned component was better able to withstand the applied forces than the previous design. We hope to mass produce our product in different sizes to fit the requirement of customer demands

Contents

[ABSTRACT 2](#_Toc325644194)

[LIST OF FIGURES AND TABLES 4](#_Toc325644195)

[1.0 SUMMARY 6](#_Toc325644196)

[1.1 The Problem 6](#_Toc325644197)

[1.2 Method of Investigation 6](#_Toc325644198)

[1.3 Conclusion 7](#_Toc325644199)

[1.4 Recommendations 7](#_Toc325644200)

[2.0 INTRODUCTION 8](#_Toc325644201)

[2.1 Subject 8](#_Toc325644202)

[2.2 Purpose 8](#_Toc325644203)

[2.3 Scope 8](#_Toc325644204)

[3.0 METHODS, ASSUMPTIONS, AND PROCEDURES 9](#_Toc325644205)

[3.1 Drawings 9](#_Toc325644206)

[3.2 Prototype Construction 13](#_Toc325644207)

[3.3 Testing Procedures 18](#_Toc325644208)

[4.0 RESULTS AND DISCUSSION 22](#_Toc325644209)

[4.1 Results 22](#_Toc325644210)

[4.2 Discussion 25](#_Toc325644211)

[5.0 CONCLUSION 26](#_Toc325644212)

[5.1 Redesign 26](#_Toc325644213)

[6.0 RECOMMENDATIONS 28](#_Toc325644214)

[6.1 Further Studies 28](#_Toc325644215)

[6.2 Suggested Actions 28](#_Toc325644216)

[7.0 REFERENCES 29](#_Toc325644217)

[8.0 APPENDIXES 30](#_Toc325644218)

# LIST OF FIGURES AND TABLES

FIGURES IN REPORT

FIG M3.1-1 Pre-Draw of Our Idea ……………………………………………………………………………………..……………….9

FIG M3.1-2 Drawing Number 1……………………………………………………………………………………..…………………..10

FIG M3.1-3 Drawing Number 2……………………………………………………………………………………..…………………..11

FIG M3.1-4 Drawing Number 3……………………………………………………………………………………..…………………..12

FIG M3.2-1 Build Process Picture……………………………………………………………………………………..…………….…16

FIG M3.2-2 Build Process Picture……………………………………………………………………………………..…………….…16

FIG M3.3-1 Slip Resistance Test Picture ………………………………………………………………………………………….…18

FIG M3.3-2 Heat Resistance Test Picture ……………………………………………………………………………………..…..19

FIG M3.3-3 Flexibility Test Picture ………………………………………………………………………………………….…….…..20

FIG M3.3-4 Water Absorption Test Picture…………………………………………………………………………………..…..20

FIG M3.3-5 Multiple Surface Test Picture………………………………………………………………………………….….…..21

FIG M3.3-6 Stress Analyzer Test Picture…………………………………………………………………………………………….21

FIG M3.3-7 Slip Resistance Test Result Picture…………………………………………………………………………………..22

FIG M3.3-8 Multiple Surface Test Result Picture ……………………………………………………………………………….23

FIG M4.1-3 Stress Test Result Graph …………………………………………………………………………………………..…….24

FIG M5.1-1 Final Prototype vs. Previous Prototype …………………………………………………………………………..27

TABLES IN REPORT

TAB M3.2-1 Decision Matrix ……………………………………………………………………………………………..……………….13

TAB M3.2-2 Bill of Materials (Purchasing for Whole Project).………………….……………………………….……….14

TAB M3.2-3 Bill of Materials (Purchasing for foil Prototype)……………………………………………………………..15

TAB M5.1-1 Bill of Materials (Purchasing Price for Sintra Prototype)………………………………………………..26

TAB M5.1-2 Bill of Materials (Actual Unit Cost for Sintra Prototype)………………………………………………..27

FIGURES IN APPENDIX

FIG M1.3-1 Gender Survey Graph……………………………………………………………………………………………………….35 FIG M1.3-2 Age Distribution Survey Graph………………………………………………………………………………………….36

FIG M1.3-3 Men and Women Shoe Sizes Survey Graph ………………………………………………………….………….37

FIG M1.3-4 Pairs of Shoes Acquired Yearly Survey Graph …………………………………………………….…………….38

FIG M1.3-5 Gum Ever Stuck to Shoe Survey Graph…………………………………………………………….……………….39

FIG M1.3-6 Hassle to Remove Gum Survey Graph ………………………………………………………….………………….40

FIG M1.3-7 Buy Our Product Survey Graph……………………………………………………………………..………………….41

FIG M1.3-8 Female Gum Ever Stuck to Shoe Pie Chart ……………………………………………………………………….42

FIG M1.3-9 Female Do You Think Hassle to Remove Gum (Those that responded yes to they have gotten gum stuck to their shoe) …………………………………………………………………………………………………………………….42

FIG M1.3-9 Female Would You Buy Our Product Pie Chart (Those that responded yes to they have gotten gum stuck to their shoe) …………………………………………………………………………………………………………………….42

FIG M4.1-3 Stress Test Result Graph……………………………………………………………………..………………..…..…….51

TABLES IN THE APPENDIX

TAB M4.1-1 Slip Resistance Test Results………………………………………………………………………..…………………….46

TAB M4.1-2 Heat Resistance Test Results ………………………………………………………………………..………………….47

TAB M4.1-3 Flexibility Test Results ………………………………………………………………………..…………………………….48

TAB M4.1-4 Water Absorption Test Results ………………………………………………………………………..……………….49

TAB M4.1-5 Multiple Surface Tests Results………………………………………………………………………..……….……….50

# 1.0 SUMMARY

## 1.1 The Problem

Women’s shoes that have flat, smooth bottoms do not provide any resistance to sticky gum. In 1871, the gum production escalated with the patent of a gum manufacture machine; today, over 374 billion sticks of gum are made yearly, and when not disposed of properly, gum becomes a sticky situation. Women in urban areas have agreed that they hate it when there is gum stuck on their shoes as evidenced by the amount of responses to the online search “I hate it when gum is stuck on my shoe.” Although there are many answers on how to effectively remove the gum from your shoes, there are no solutions on how to keep the gum from sticking to the shoe.

## 1.2 Method of Investigation

Surveys: To justify our problem statement we surveyed 339 people in the areas of Chicago and Bloomingdale. In Chicago surveys were given at the Beam and at Bloomingdale surveys were given at the Stratford Square Mall. Numerous factors were taken into consideration, and surveys were revised multiple times to make them un-biased and the best they can be. Refer to APPENDIX 1-A to get more of an understanding of the type of questions that were asked.

Interviews: We asked numerous individuals that walk in Chicago to take a personal interview with our group. We also interviewed the custodian at Bartlett High School; however, this was more of an informational interview for our own knowledge. Refer to APPENDIX 1-B for more information on the Chicago interviews and refer to APPENDIX 1-C for more information on the Bartlett High School custodian interview.

Market Research : We researched past and present solutions that we considered competition. However none of these products were solely made for preventing gum from sticking to the shoe. Some commonly used products were Goo Gone and Stel Gum Remover. We also research methods that help remove gum off the shoe once it has stuck to it. All these solutions showed that individuals actually researched how to remove gum off the shoe, and that gum sticking to the shoe is actually a problem.

Patents/Artifacts: We researched numerous patents of previous products such as Gum Storage Containers, and apparatuses for removing chewing gum. Even though these are not directly related to our product, however, we consider them competition. This is because both products either reduce the chance of gum getting stuck to the shoe, or remove the gum once it has stuck to the shoe. Many artifacts such as newspaper articles also justified our problem statement. One article, particularly, stated that New York City spends 250,000 dollars a year to remove gum of the sidewalks. Thus stating how much gum is actually on the sidewalk every year.

## 1.3 Conclusion

Survey Results: From collected market research data, we concluded that our problem was justifiable. Our data from the survey experience help validate this conclusion. We surveyed approximately 339 people, both female and male. More than ninety percent of people believed that gum getting to their shoe is a hassle. Also, more than half of all the people we surveyed claimed that they would buy our product if we mass produced it. We used Microsoft Exel to create numerous graphs that compared and analyzed our project in great depth. These graphs (FIG M1.3-1 to FIG M1.3-10), extensive results, and analyzed data can be found in APPENDIX 1-D.

Chicago Interview Results: We interviewed four people. Out of those four people the majority said that they go into the city often for either work or school. They also said they have never have seen a product similar to ours. Lastly, they said that they would not mind purchasing our product, as long as it is affordable. Their reactions to the interview: glad, and anxious to be answering questions. To understand what kind of questions we discussed refer to APPENDIX 1-E.

Custodian Interview Results: The custodian of Bartlett High School stated that gum on the ground is a serious problem for Bartlett High School. He has even seen students stepping on pieces of gum. The most frequent places that contain gum are hallways and belchers. Refer to 1-5 in the appendix to view the responses in more detail.

Overall Conclusion Method of Investigation: According to our surveys, market research, and interviews we have concluded that gum getting stuck to the shoe is a serious problem. This is because numerous products and methods have been created to remove gum of the shoe. Also our surveys and interviews validated that our problem was legit and justifiable.

## 1.4 Recommendations

We contacted experts in engineering, chemical engineering, and material engineering. These experts help validate our problem statement and help propose some suggestions for furthering our project. One expert in particular gave us a great outline to follow for our project. This outline included videos we could watch on gum-resisting surfaces, and materials that might be helpful for our project. This outline also included some background information such as why gum sticks on leather shoes and coatings that may help prevent oils from sticking to a surface.

# 2.0 INTRODUCTION

## 2.1 Subject

Numerous individuals walk everyday on sidewalks in both the city and the suburbs. Many citizens have noticed that gum liter on sidewalks has become a huge problem for a clean community and individuals. Gum especially becomes a burden when it sticks to shoes’ of walkers. Women that wear flat bottom shoes find it especially difficult to remove gum off their new shoes, due to its elasticity and stickiness. Countless products have been made in order to remove the gum after it has stuck to the shoe; however, no product has solely been made to prevent the gum from sticking to the shoe in the first place. Gum removing products may leave gum residue and may not even completing take the gum off the shoe. But with Gum Shield, there is no worry about removing gum off the shoe because our product can be disposed of once gum has stuck to it. Once disposed of, the bottom of the shoe remains clean and gum-free.

## 2.2 Purpose

Numerous products such as Goo Gone and Stel Gum Remover have been made to address the problem of removing gum from surfaces. However, these products remove the gum after it has stuck to the surface, which could lead to damaging and destroying newly bought items. Other lesser known products such as Gummy Bins and Gum posters have been made to limit the number of gum pieces found on the ground and also create public awareness of keeping the community clean. Some products are design specific in limiting the amount of gum stuck to the shoe. Pave Saver, for example, coats a surface which is able to resist gum and certain liquids. While others, such as the gum storage container, are more concerned with limiting the amount of gum stuck to the floor, by impacting the individual’s gum chewing habit. All these products may help reduce the possibility of gum sticking to the shoe, or remove the gum once it has stuck to the shoe; however, there is no affordable product whose sole purpose is to shield the product from sticking to the shoe. Thus, we have developed a product whose main purpose is to prevent the gum from sticking to the shoe sole in the first place.

## 2.3 Scope

This report provides technical information on the geometry, material make-up, manufacturing methods, and mechanical operation of the Gum Shield. This report also includes basic market research, documentation on the development of the product, and results of testing the product. It shows how the final product came to be brought about, based on the results of the data collection. Not included in this report are discussions of alternative problem statements, background research done in order to further develop our product, and every material consideration for our product. We will be receiving information from experts in the fields of chemical engineering, and engineering. Our group consists of three students: Avani Patel, Phil Bagley, Kamile Berenyte.

NOTE: A basic understanding of terminology related to technical drawing, mechanical design, and material properties is assumed.

# 3.0 METHODS, ASSUMPTIONS, AND PROCEDURES

## 3.1 Drawings

Pre-Draw of Our Idea:

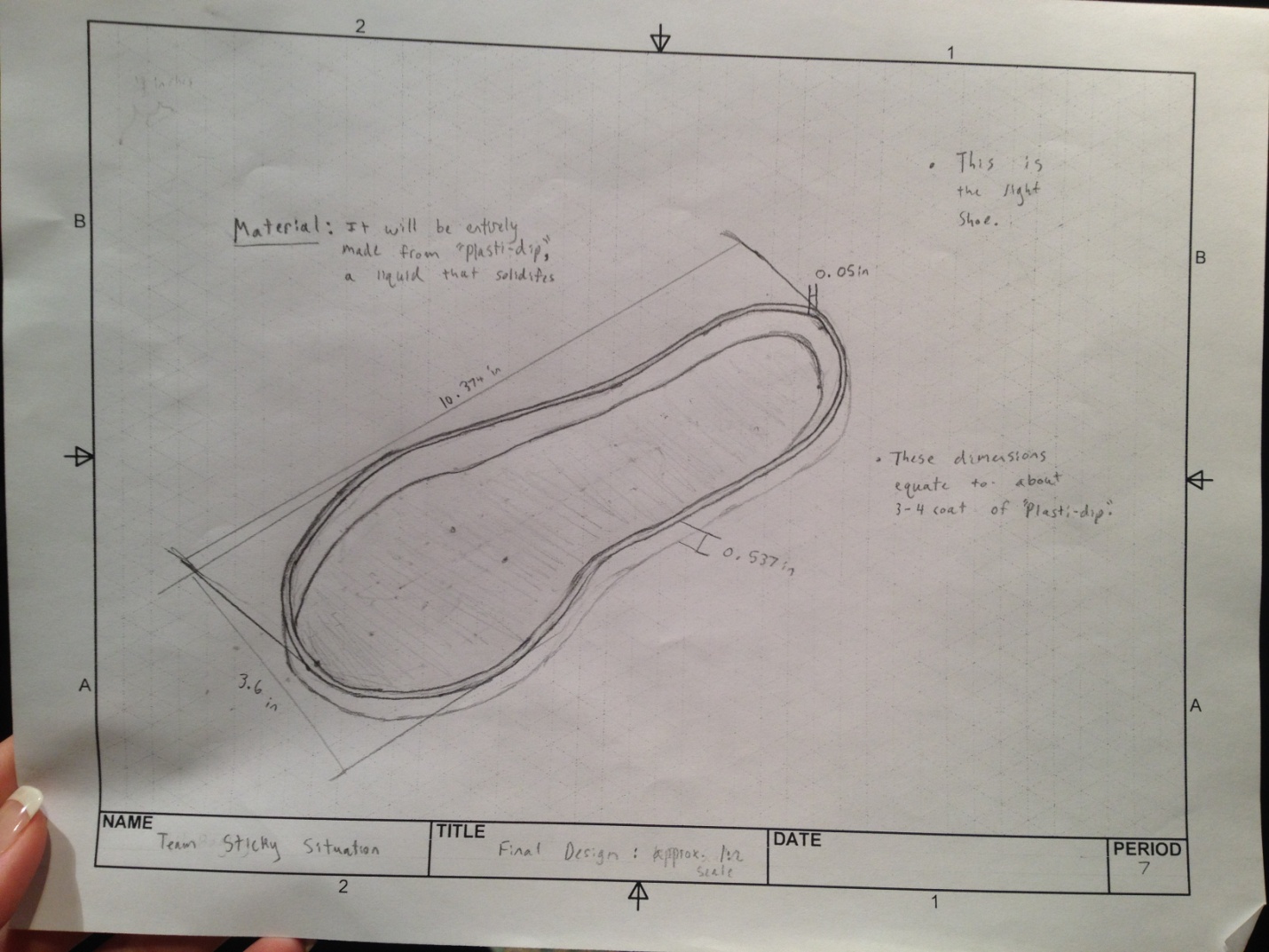


FIG M3.1-1

CAD-Drawings of our Idea:

*Drawing Number 1:*

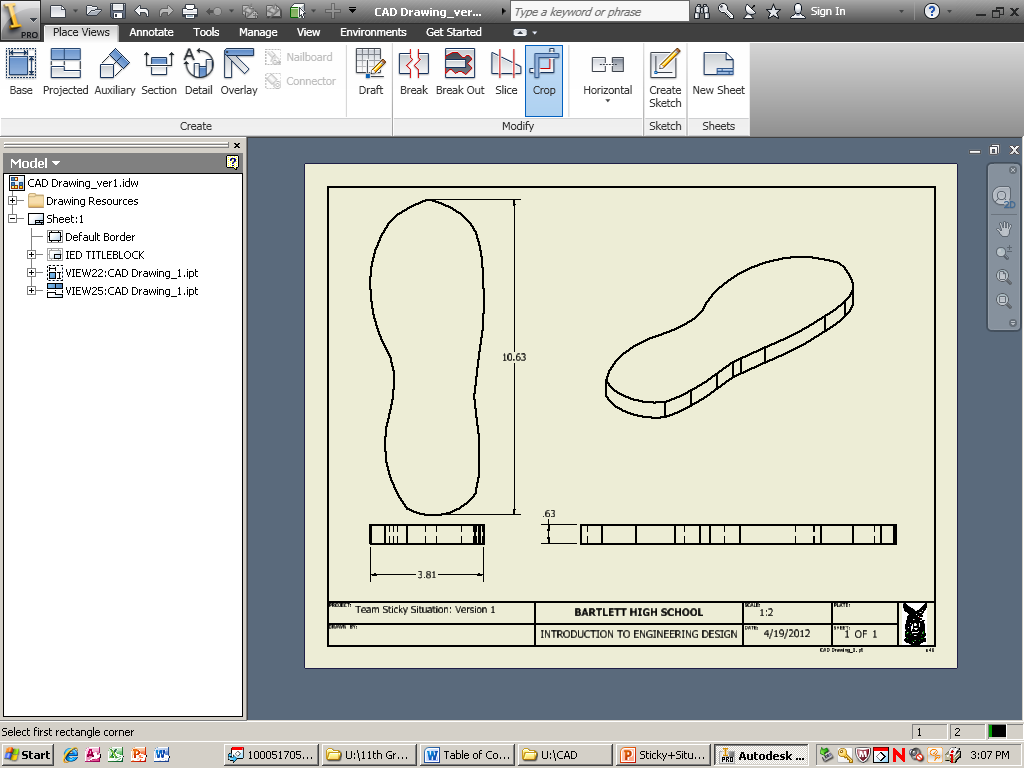


FIG M3.1-2

*Drawing Number 2:*

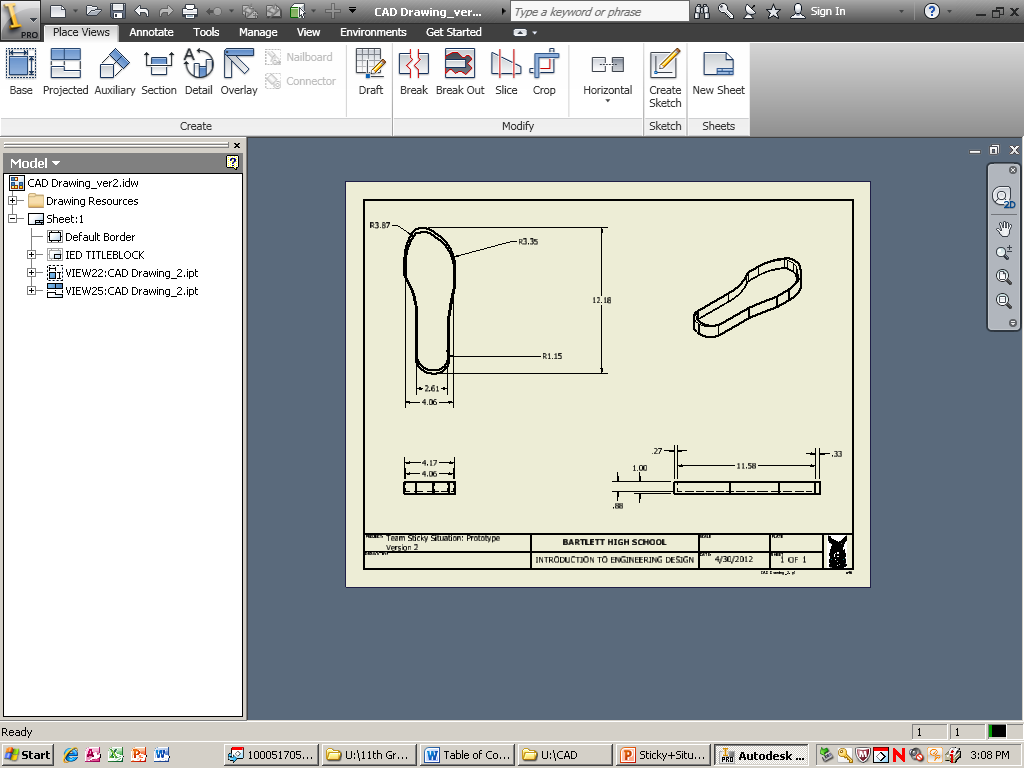


FIG M3.1-3

*Drawing Number 3:*

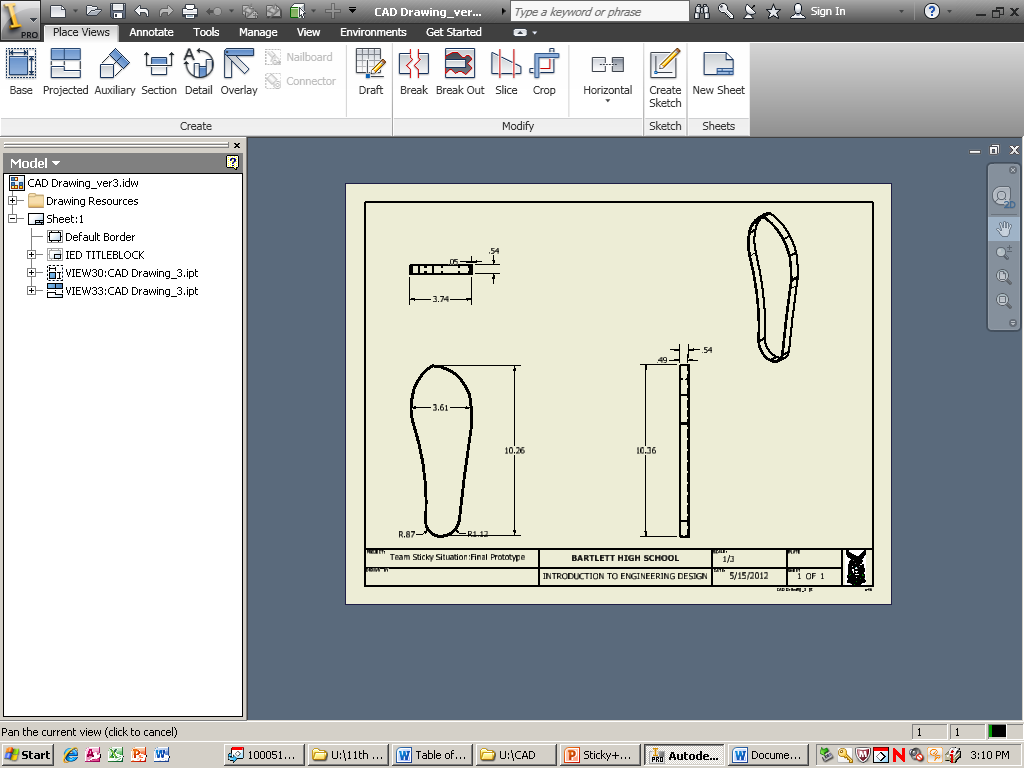


FIG M3.1-4

## 3.2 Prototype Construction

Decision: Numerous methods were used to develop our prototype. First of all, we constructed different prototypes to test different ideas that we had to solve our problem. Second of all we did solution specific research. For example for the sticker idea we contacted 3M and researched easy-to-remove materials. Lastly, we used a decision matrix to finalize the idea on how to solve our problem statement. Here is the decision matrix:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Problem Statement Ideas** | | | | | | | | |
| **Criteria** | **Weight** | Idea 1 | Idea 2 | Idea 3 | Idea 4 | Idea 5 | Idea 6 | Idea 7 | Idea 8 | Idea 9 |
| Product will be able to prevent gum from sticking to the shoe. | **3** | 4 | 4 | 2 | 5 | 5 | 3 | 3 | 2 | 4 |
| The product can be accomplished in the given time. | **2** | 2 | 4 | 1 | 2 | 3 | 2 | 2 | 1 | 2 |
| The product can be made with the available resources. | **3** | 2 | 4 | 1 | 1 | 3 | 1 | 1 | 1 | 3 |
| The product is marketable. | **1** | 5 | 5 | 3 | 2 | 4 | 3 | 3 | 3 | 3 |
| Product is affordable. | **1** | 4 | 4 | 1 | 3 | 4 | 2 | 2 | 2 | 4 |
| Materials used are durable. | **2** | 2 | 4 | 3 | 4 | 1 | 2 | 2 | 2 | 2 |
| Product has appealing appearance. | **1** | 5 | 2 | 1 | 2 | 1 | 3 | 3 | 2 | 2 |
| Product is slip resistant. | **3** | 5 | 5 | 4 | 1 | 2 | 2 | 3 | 1 | 4 |
| Product is water resistant. | **3** | 2 | 4 | 2 | 5 | 5 | 4 | 4 | 5 | 4 |
| Product is testable. | **2** | 3 | 5 | 4 | 4 | 4 | 3 | 3 | 1 | 4 |
| Adjustable to shoe size. | **1** | 1 | 4 | 2 | 2 | 2 | 2 | 2 | 1 | 1 |
| Adjustable to shape of the sole. | **1** | 1 | 4 | 2 | 2 | 2 | 2 | 2 | 1 | 1 |
| Total Score |  | 69 | 96 | 52 | 66 | 74 | 56 | 63 | 44 | 72 |

TAB M3.2-1

Idea 1- Sticker Idea ( Multiple layers of slip-resistant material that peel off when the gum is stuck to it)

Idea 2- Cover Idea ( Rubber sole that stretches around the shoe and can be removed from the shoe when the gum is stuck to it)

Idea 3- Sensor Idea ( signals the walker of gum on the ground)

Idea 4- Resistant material Idea (on the bottom of the shoe with slip resistant on the edges of the product (Teflon Fabric))

Idea 5- PVC Glove Idea (glove material on bottom of the shoe that resists gum)

Idea 6- Liquid Idea (Rubber sole with slots that fill with PaveSaver)

Idea 7- Liquid Idea (Rubber sole with slits that fill with PaveSaver)

Idea 8- Hydrophilic Idea ( A stick on layer that collects water, making it difficult for gum to stick to)

Idea 9- Resistant Material Idea and Sticker Idea Combined (only one layer of gum resistant material on bottom of the shoe that can be peeled off)

Bill of Materials (Purchasing for Whole Project):

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Material | Description | Unit Price | Quantity | Total Price |
| Plasti Dip | Material composition of our product | 6.88 | 4 | 27.52 |
| Aluminum Foil (roll=25 square feet) | Used to mold product. Allows the plasti dip to be easily removed and keep shape. Also allows product to take shape without the shoe getting ruined. | 0.99 | 2 | 1.98 |
| Paint Brush | Used to paint on plasti dip | FREE | 1 | 0 |
| Clamps | Used to hold shoe on a flat surface when painting plasti dip on it. | FREE | 4 | 0 |
| Sintra Plastic (2 ft x 2 ft) | Used as a mold and for a smoother ending product | 10.00 | 1 | 10.00 |
| Tri-Fold Poster | Used to present our findings to the public | 3.34 | 2 | 6.88 |
| Women’s Shoe Pair | Used to put foil onto it so product can take shape | FREE | 1 | 0 |
| PBC Pipe (2.5 feet long) | Used as arm in the pendulum | FREE | 1 | 0 |
| Wood (3 in x 3in) | Used to put rod through and hold the whole pendulum together | FREE | 1 | 0 |
| Steel Rod (11/64 inch) | Allows the arm to swing freely | FREE | 1 | 0 |
| Fischertechnik materials (rods, screws) | Used to build the stand for the pendulum and build the stress analyzer machine | FREE | According to directions | 0 |
| Scotch double sided tape | Used in our prototype- simulate sticker idea | 2.69 | 1 | 2.69 |
| Cardboard (2 ft x 2 ft) | Used in our prototype- simulate material we would use for the real product | FREE | 1 | 0 |
| Fabric (6 in x 6 in) | Used in our prototype- simulate material we would use for the real product | FREE | 1 | 0 |
| Sandpaper (6 in x 6 in) | Used in our prototype- simulate material we would use for the real product | 0.99 | 1 | 0.99 |
| Black Safety Tape | Used for our prototype- simulate slip resistant border | 5.97 | 1 | 5.97 |
| Prototyping material (one sheet which is 1 in x 24 in x 8 ft) | Used to build our prototypes | 11.00 | 1 | 11.00 |
|  |  |  |  | 67.03 |

TAB M3.2-2

Bill of Materials (Purchasing for foil Prototype):

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Material | Description | Unit Price | Quantity | Total Price |
| Plasti Dip | Material composition of our product | 6.88 | 4 | 27.52 |
| Aluminum Foil (roll=25 square feet) | Used to mold product. Allows the plasti dip to be easily removed and keep shape. Also allows product to take shape without the shoe getting ruined. | 0.99 | 2 | 1.98 |
| Paint Brush | Used to paint on plasti dip | FREE | 1 | 0 |
| Clamps | Used to hold shoe on a flat surface when painting plasti dip on it. | FREE | 4 | 0 |
|  |  |  |  | 29.5 |

TAB M3.2-3

Build Process of Product:

1. Use one, continuous piece of aluminum foil to completely cover the bottom of and about half way up the shoe.
2. Attach the one of the “one handed” bar clamps to a table upside down, so that the excess bar length is pointing upwards.
3. Attach the second clamp about ¾ of the shoe length away. These two clamps will be used to set up the shoe for drying. (Note: this setup is necessary for shoes like platforms or heels that when set upside down, would not provide a level drying surface.)
4. Put the Aluminum foil covered shoe on top of the “one handed” bar clamps. If necessary, use additional aluminum foil to secure the shoe to the top of the clamps. Make sure that the bottom of the shoe is level.
5. Paint on the “Plasti-dip” on the bottom of the shoe as evenly as possible. Cover the sides a little past the thickness of the sole.
6. After 30 minutes, apply another coat. Reapply until there are 3 coats.
7. 4 hours after the last coat, the shield will have completely solidified. Remove the shield with the foil from the shoe, and then remove the foil from the shield.
8. Use scissors to cut the edges straight and trim down any unevenness at the sides.

NOTE: Look at FIG M3.2-1 and FIG M3.2-2 to see how the build process occurred:



FIGM3.2-1



FIG M3.2-2

Bill of Materials (Actual Unit Cost for Foil Prototype):

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Material | Description | Unit Price | Quantity | Total Price |
| Plasti Dip | Material composition of our product | 6.88 | 1/3 of one can | 2.29 |
| Aluminum Foil (roll=25 square feet) | Used to mold product. Allows the plasti dip to be easily removed and keep shape. Also allows product to take shape without the shoe getting ruined. | 0.99 | ½ the roll | .50 |
| Paint Brush | Used to paint on plasti dip | FREE | 1 | 0 |
| Clamps | Used to hold shoe on a flat surface when painting plasti dip on it. | FREE | 4 | 0 |
|  |  |  |  | 2.79 |

TAB M3.2-4

We ended up using the majority of things we bought for this project. The bill of materials reflects accurately what we ended up using in our project, what the function of the material was in our project, and how much the material cost in total.

## 3.3 Testing Procedures

Numerous tests were conducted to validate the functionality and durability of our product. These tests functioned as a check point in our project to help us improve our product as a whole. Multiple tests were conducted to test whether our product would work in the real world.

Slip Resistance Test: For this test we built a machine that actually helped us complete this task (Refer to FIG M3.3-1). The machine was built to replicate a pendulum with a shoe connected to the end with our product. The pendulum was then tested on different surfaces that a normal person might walk on. These surfaces included tile, grass, carpet, and pavement. The product was then tested again on the same surfaces, expect this time there was water on them. The reason for the water was because sometimes surfaces are wet, and we wanted to test whether the product to avoid slipping on these surfaces, even if water was present. To understand the exact procedure of the test and the materials needed, please refer to APPENDIX 3-A.



FIG M3.3-1

Heat Resistance Test: For this test we put our product through the t-shirt dyer at different heat settings. Each different heat setting represented different temperatures. The first round, the product was placed in the dyer at heat setting 4, which was an appromixately 140 degree. The second round, the product was placed in the dyer at heat setting 5, which was an approximately 170 degree. The third round, the product was placed in the dyer at heat setting 6, which was an approximately 200 degree. After each round the product was placed on an outline that we traced before putting the product inside the dyer. Then we marked three points (1/3, 1/2, and 2/3 of product) and the length, and we measured the difference, if any between the points from before the heating and after the heating. To see how the dryer looked and how our product looked in the dryer refer to FIG M3.3-2. To understand the exact procedure of the test and the materials needed, please refer to APPENDIX 3-B.



FIG M3.3-2

Flexibility Test: For this test we took our product and bent it at different angles at different location to make sure that it does not snap when a person puts on the shoe, or lose shape if bent in storage. The angles bent at were 60, 120 and 180 for 10 seconds each. The locations the product was bent at were 1/3, 1/2, and 2/3 of the product. To see how the process looked refer to FIG M3.2-3. To understand the exact procedure of the test and the materials needed, please refer to APPENDIX 3-C.



FIG M3.3-3

Water Absorption Test: For this test we took our product and submerged it into a bin of water. We noted the weight after one minute, five minutes, ten minutes, and 60 minutes of water submergence. We want to make sure that the product does not gain any water if the consumer wears it in the rain. To see how the process looked refer to FIG M3.3-4. To understand the exact procedure of the test and the materials needed, please refer to APPENDIX 3-D in the appendix.



FIG M3.3-4

Multiple Surface Tests: For this test we chewed gum for five minutes. Then we placed the gum onto different surfaces of concrete, carpet, tile, brick, and grass. A volunteer walked normally toward the gum with the product and stepped on the gum. Then we observed if gum was stuck to the product, and how it looked after it was stuck. To see how the process looked refer to FIG M3.3-5. To understand the exact procedure of the test and the materials needed, please refer to APPENDIX 3-E.



FIG M3.3-5

Stress Test: For this test we built a stress analyzer that measured the force the product is able to withstand before ripping apart. This stress analyzer was more accurate than the stress analyzer in the lab (Refer to FIG M3.3-6). However, we still put the product in the lab stress analyzer four times. To understand the exact procedure of the test and the materials needed, please refer to APPENDIX 3-F.



FIG M3.3-6

# 4.0 RESULTS AND DISCUSSION

## 4.1 Results

Slip Resistance Test Result: This test yielded results that were not too surprising. When there was no water on the surfaces of grass, tile, carpet and pavement the Gum Shield easily stopped. This was because the product was made out of rubber, and rubber tends to be slip-resistance based on the research we did when picking the material for our product. When there was water on the surfaces of grass, tile, carpet and pavement the Gum Shield stopped on all the surfaces expect the tile. This happened because all the other surfaces absorbed the water (you could tell when you touched it after the experiment) and the tile did not absorb the water at all. This is most evident when our group touched the tile with water, and noticed that all the water was sitting there. Overall, the test went in our favor- expect the tile with water results. However, in real life even shoes that are slip resistant tend to slip on water with tile. That is why they create wet floor signs because people tend to slip when tile is wet, even with shoes on. Thus, considering our product passed all other surface tests, we think of it as positive results. To see one of the surface results refer to the FIG M4.1- 1, and to look at the results of this test in more detail look at the TAB M4.1-1 in APPENDIX 3-A.



FIG M4.1- 1

Heat Resistance Test: This test yielded results that were unchanging. Both the product before heat was placed on it, and after heat was placed on it yielded the same results. All three points and length, no matter what degree of heat was applied to it, did not show any difference in size or shape. This shows that no matter what degree of weather in the summer it is in, the product will not melt. Concrete and asphalt tend to get around 140 degrees, and we measured to 200 degrees, and still the product did not melt. Thus, this shows even if the product was placed on a surface of 200 degrees, it would not melt. To look at the results more in detail refer to TAB M4.1-2 in APPENDIX 3-B.

Flexibility Test: This test yielded results that were unchanging. The product both before it was bent and after it was bent remained the same. Thus, no matter at what angle the consumer decides to bend the angle, the product will remain unchanged. To look at the results in detail refer to TAB M4.1-3 in APPENDIX 3-C.

Water Absorption Test: This test yielded results that changed very slightly. The product, before and after it was placed in water remained approximately the same weight. The slightest weight change probably occurred because of experimentation error. It remained approximately the same weight (only one gram difference) regardless of the amount of time the product was in the water. Thus this means even if the consumer stands in rain water for an hour, the product itself will not absorb any water, and if it does like it did in this experiment the absorption will be minimal. To look at the results in more detail refer to TAB M4.1-4 in APPENDIX 3-D.

Multiple Surface Tests: This test yielded results that were not at all shocking to us. The gum stuck to the product no matter what surface it was on. The surfaces it stuck on included: grass, concrete, carpet, tile, and brick. It is a good thing that the gum stuck to the product, and not the shoe sole. It proves that our product accomplished its given task of preventing gum from sticking to the shoe. Thus, no matter what surface our product is on, gum will stick to it and it will prevent gum from sticking to the shoe sole. To see one of the surface results refer to FIG M4.1-2, and to see the results of this test in more detail refer to TAB M4.1-5 in APPENDIX 3-E.



FIG M4.1-2

Stress Test: This test was very surprising. Our product did not break, or even rip at all! First we placed it in a stress analyzer machine that we hand-built. It turned out that our product exceeded the amount of weight that the stress analyzer machine could measure. The machine could not measure past 60 Newton, and not surprisingly enough our product went beyond that. Then we turned to a less accurate, but still useful stress analyzer machine in the lab. This machine could not also break out product (however it did stop at a certain amount of Newton because it thought it broke it, clearly indicated in the graph of FIG M4.1-3). We thought it might have been an error, so we tried it three more times. Surprisingly enough, all three times the same thing happened. The product was not changed at all. Thus, this proves that no matter how far the consumer pulls the product when putting it on the shoe, it will not break. We are positive that no consumer will have to stretch the product more than 60 Newton because we are going to customize every size when it is mass produced. Thus, the product passed this test with flying colors. To look at the results in more detail refer to FIG M3.1-3 in APPENDIX 3-F.

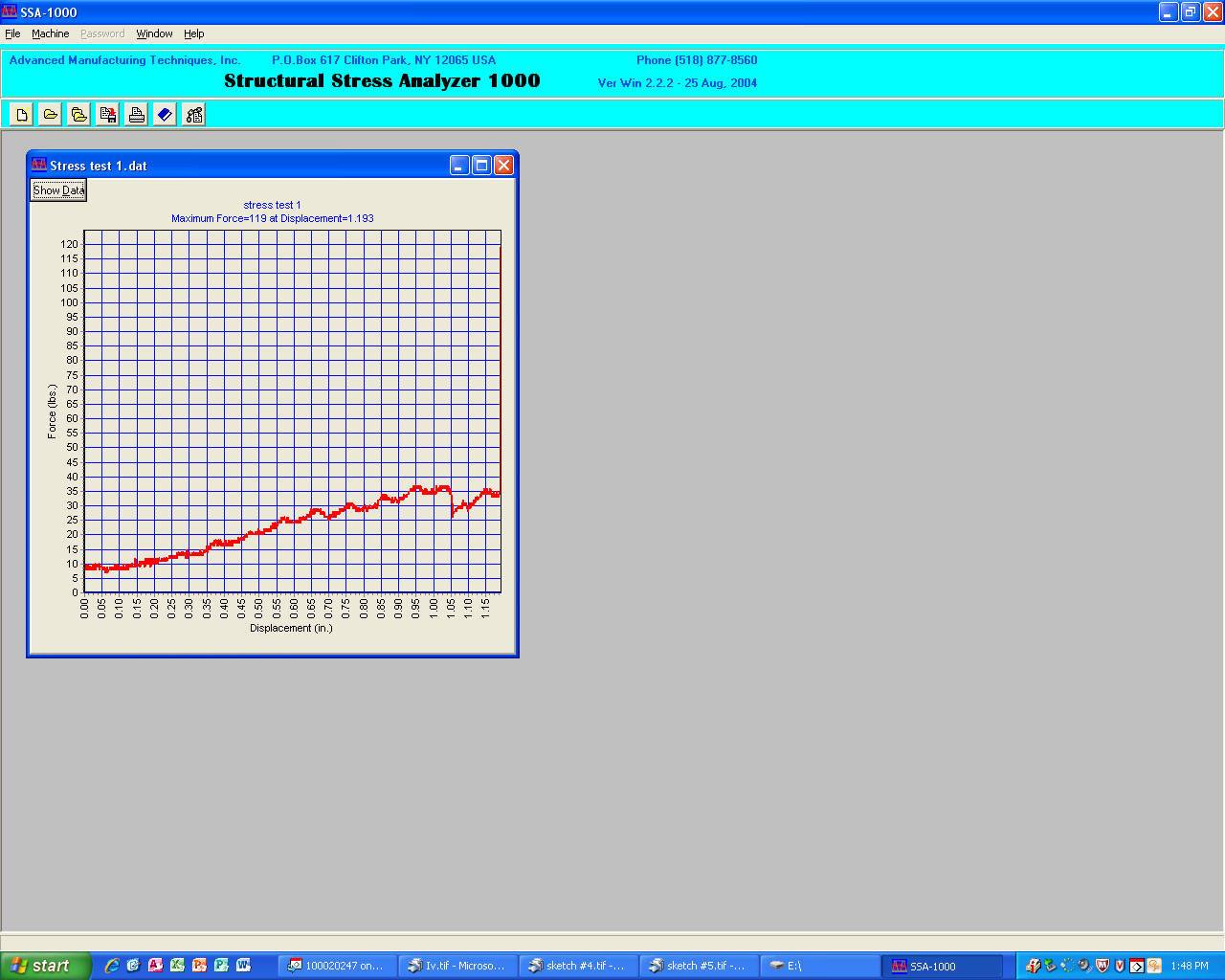


FIG M4.1-3

## 4.2 Discussion

Overall our product passed the majority of our tests with positive results- which was very surprising. The majority of the tests yielded results that were in our favor. What is meant by this is that we expected certain results for our product, and most of the time we got those results. The tests went very well. We choose these tests in particular because we wanted to highlight the greatest concerns our product might face. There may have only been six tests, but these six tests were what we felt were the most important to our consumer. We also felt that these six tests represented our product very well, and thus we felt no need to conduct any different tests than those.

# 5.0 CONCLUSION

## 5.1 Redesign

We decided not to change the material composition of the product, but we did decide to change the appearance of the product. We noticed that the product material we had used in our tests yielded great results, so we felt there was no need to alter that. The only thing, if anything that we changed was the appearance of the product. We decided that the ridges and uneven layers caused by the foil, when it was molded into the product, were unappealing. Thus, we decided to use a Sintra plastic cut-out of the shoe and paint the Plasti dip onto the material. After it dried, it was a lot smoother and ridge-free. Overall we did not change much to our product after our tests because we thought the material composition was up to pare with our project; however, we did change the appearance of the product.

Revised Build Process:

1. Cut up the Sintra plastic to four pieces of 1’x6”.
2. Glue the four pieces together with contact cement.
3. Outline the shape of the shoe on the plastic.
4. Use a vertical band saw to cut out the shape of the shoe.
5. Use a paintbrush to evenly apply Plasti-dip to one side of the shoe shape and the sides.
6. Let dry for at least 30 minutes.
7. Apply two more coats, letting each one dry.
8. After four hours, the Plasti-dip is completely dried and can be removed.
9. Use scissors to cut off any unevenness.

Bill of Materials (Purchasing Price for Sintra Prototype):

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Material | Description | Unit Price | Quantity | Total Price |
| Plasti Dip | Material composition of our product | 6.88 | 1 | 6.88 |
| Sintra Plastic (2 ft x 2 ft) | Used as a mold and for a smoother ending product | 10.00 | 1 | 10.00 |
| Paint Brush | Used to paint on plasti dip | FREE | 1 | 0 |
| Clamps | Used to hold shoe on a flat surface when painting plasti dip on it. | FREE | 4 | 0 |
|  |  |  |  | 16.88 |

TAB M5.1-1

Bill of Materials (Actual Unit Cost for Sintra Prototype):

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Material | Description | Unit Price | Quantity | Total Price |
| Plasti Dip | Material composition of our product | 6.88 | 1/3 of one can | 2.29 |
| Sintra Plastic (2 ft x 2 ft) | Used as a mold and for a smoother ending product | 10.00 | ¾ of sheet | 7.50 |
| Paint Brush | Used to paint on plasti dip | FREE | 1 | 0 |
| Clamps | Used to hold shoe on a flat surface when painting plasti dip on it. | FREE | 4 | 0 |
|  |  |  |  | 9.79 |

TAB M5.1-2

Results of Redesign:

We like our final product because of its new appearance. The one thing, if we continued this project, we would probably fix would be to make sure the product does not shrink. Our idea is to manufacture our product one shoe size bigger than need because from building the product we have understood that the product tends to shrink when it dries. Clearly indicated in FIG M5.1-1

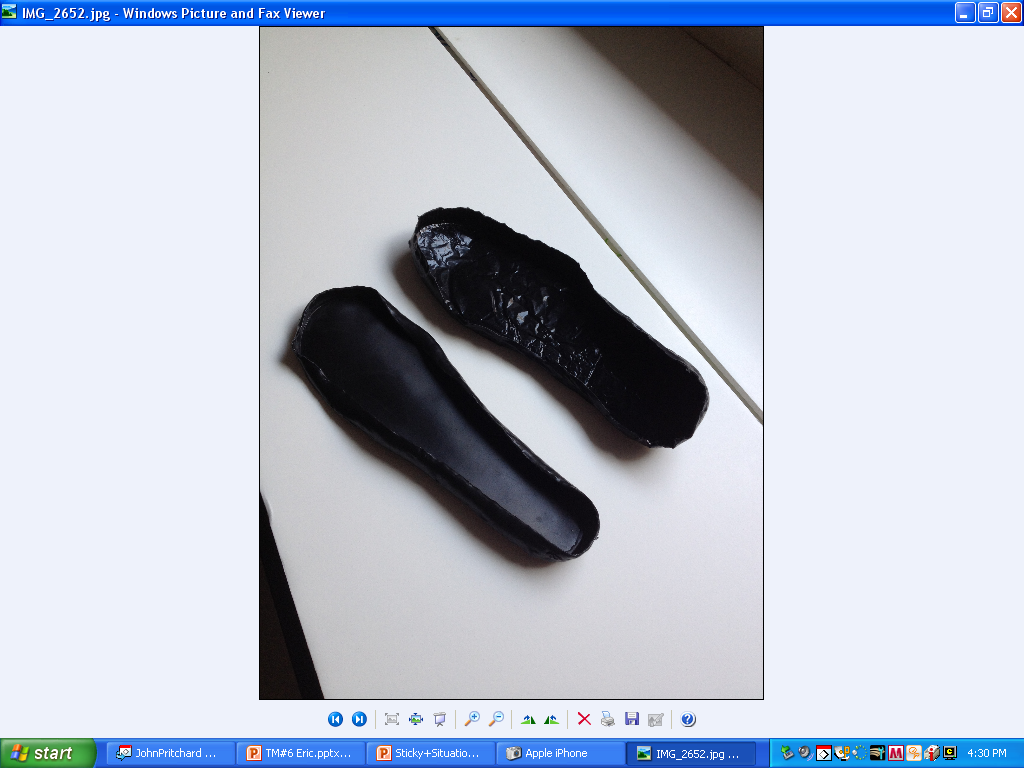


FIG M5.1-1

# 6.0 RECOMMENDATIONS

## 6.1 Further Studies

There were several unknowns from our project that could affect the performance of our solution. Further studies should be conducted in the following areas:

* Mass production process
  + How exactly is this product going to be mass produced?
    - Injection mold, mold cut out like we had? What manufacturing company will sell it to us?
    - Material for mold- Sintra plastic? Another plastic? Foil?
    - Plasti Dip Product- will a manufacturing company create a chemical process that will make the liquid? Or will we us different rubber material?
  + Projected Cost to manufacture product?
    - Includes price for electricity, space used to rent, machines, etc.
  + Selling Price?
    - What will we sell for to gain profit? The actual unit cost to build the Sintra prototype was $9.97; however once we have a mold we would not need to build the mold again. So we would probably sell around $6.00 to gain profit.
  + Different Sizes?
    - Will we customize the shoe sizes?
    - Will we create a standard size that fits all?
* Price of product when mass produced
* Where the product will be sold
* How the product will be sold

## 6.2 Suggested Actions

After the final product is produced, decide the communication of the product. Decided at what price the product will be sold based on the mass production of the product. Make sure to include the money need for the machines that will help produce the product. Also decided how and where the product will be sold. Will it be a product sold directly to the customer, or sold to a retail that will sell the product to the customer? Lastly, decide how the product will be mass produced. Will there be a mold of our product that will be coated with plasti dip, or will we use injection mold to create our product? Overall, there are numerous things to consider at this point.

# 7.0 REFERENCES

* City of Westminster. "The Westminster Gumbusting Campaign." *Westminster City Council -*. Web. 20 May 2012. <http://www.westminster.gov.uk/services/environment/streetcareandcleaning/gumbusters/>.
* Contributor, An EHow. "How to Remove Gum From a Shoe | EHow.com." EHow | How to Videos, Articles & More - Discover the Expert in You. | EHow.com. Web. 28 Nov. 2011. <http://www.ehow.com/how\_879\_remove-gum-shoe.html>.
* Google Patents. "Used Chewing Gum Storage Receptacle." *Google Books*. Web. 20 May 2012. <http://www.google.com/patents?id=GXwrAAAAEBAJ>.
* Go-Gum. "Invisible Chewing Gum and Stain Repellent." *Pave-Saver Is the Ultimate Invisible Chewing Gum Repellent for Pavement Surface Protection and Stone Protection from Go-Gum*. Web. 20 May 2012. <http://www.getridofgum.com/anti\_chewing\_gum\_solution.html>.
* Goo Gone. "Home - Goo Gone." *Home - Goo Gone*. Web. 20 May 2012. <http://googone.com/>.
* Stel. "Spray Cleaners | Ink & Gum Remover | Tygris | R255." *Remove Chewing Gum*. Web. 20 May 2012. <http://www.specialisedtools.co.uk/spray-cleaners/285-remove-chewing-gum-spray-cleaners-gum-removing-tygris-r255.html>.
* Straight. "The Surprising Solution to the Chewing Gum Problem." *Gummy BinsÂ®*. Web. 20 May 2012. <http://www.gummybin.com/>.
* Performix. "Plasti Dip." *Protective Coating Products*. Web. 20 May 2012. <http://www.plastidip.com/home\_solutions/Plasti\_Dip>.

# 8.0 APPENDIXES

**APPENIX 1-A Survey Outline:**

Sticky Situation Survey

Investigating the problem of gum stuck on shoes

*Please circle your answers*

1. Gender: Male Female
2. Which age group do you belong to?

Under 9 9-15 16-22 23-29 30-36 37-43 44+

1. What shoe size do you wear?

*Circle both numbers if you are a half-size*

5 or under 6 7 8 9 10 11 12 13 14 15+

1. Approximately how many pairs of shoes do you acquire each year?

0 1 2 3 4 5 6 7 8 9+

1. How often do you chew a piece of gum?

Constantly hourly daily weekly monthly yearly never

1. Has gum ever gotten stuck to the bottom of your shoe?

Yes No

1. About how many times in the last year?

Does not apply 1 2 3 4 5+

1. **Do you think** it is a hassle to remove the gum stuck on a shoe?

Yes No

1. Is there a certain place that you have noticed gum on the ground? *Circle all that apply*

subway school office airport mall city sidewalk other\_\_\_\_\_\_\_\_\_\_

1. What time of year (season) have you noticed gum gets stuck to shoes most often? *Circle all that apply*

Summer fall winter spring

1. Do you know of a method that can **prevent** gum from sticking to the bottom of shoes?

Yes No

If yes, what is it? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. How **would/have** you removed the gum from the bottom of a shoe? *Circle all that apply*

adhesive remover sand/dirt method scraping method did not remove other\_\_\_\_\_\_\_\_\_\_\_

1. If a product was invented for the bottom of shoes so that made it resistant to gum, would you be interested in the product?

Yes No

1. How much would you be willing to spend on such a product (per pair of shoes)? *Circle only one*

$1-3 $4-7 $8-12 $13-16 $17-20 $21+

**APPENDIX 1-B Chicago Interview Outline:**

Questions involving in our interviews (Chicago Land Area):

1. Do you spend a lot of time walking in the city?
2. about how much? Daily? Hourly?
3. Do you live in the city or commute here for work, school, etc.?
4. Do you notice a lot of gum covering the sidewalks?
5. If yes, do you try to avoid stepping on it?
6. Have you ever had gum stuck on the bottom of your shoe?
7. Was it from walking in the city?
8. How frequently does this happen?
9. How did you remove the gum?
10. or did you leave it there or dispose of the shoe?
11. Was it easy or time consuming to remove it?
12. What would you prefer it to be like, gum not stick to shoes at all, there not be any gum on the sidewalks or what?
13. Do you know if there is anything being done to prevent gum from being disposed on the ground?
14. how about from sticking to shoes?
15. do you think those products or processes are effective?
16. What if there was a product to apply to the bottom of the shoe to prevent gum from sticking?
17. do you think it would be worth your money and interest?
18. do you know of any existing similar products like that?

**APPENDIX 1-C Custodian Interview Outline:**

1. Do you think gum disposed on the ground is an issue?
   1. Yes it a serious problem, especially when gum sticks to floors and shoes.
2. If you had to estimate the amount of gum you pick up everyday?
   1. Easily ten pieces of gum in the hallway alone, and another ten in the gym. After a while the gum pieces add up!
3. How long does it take to remove each piece of gum?
   1. Depends on the surface. It is harder to remove on carpet, but not so much on tile. It is also very hard to remove gum from chairs and computer tables. We use a spray that freezes the gum piece so it can be easily removed from the surface.
4. What locations are most likely to have gum in the building of Bartlett High School?
   1. Gym, Hallways, Computer Labs
5. Do you notice students getting gum stuck to their shoe?
   1. Not to often, but I have. I have noticed their expression turn annoyed or angry when this happens

**APPENDIX 1-D Survey Results:**

FIG M1.3-1

In general we surveyed more female than males. Even though this may be true, the numbers of males are not that far behind that of females. The numbers can never be exactly even because there is always that factor of not finishing the survey, or incorrectly marking an answer. Even though our product is aimed toward women, we felt it was necessary to also include males because our ending product very much can also be used toward men. Also by including both genders we get a variety of responses that may help us improve and solve our problem.

FIG M1.3-2

We definitely see a variety of age groups within this chart. For females the peaks seem to be at under 16, and 16-22. While for males the peeks are at under 16, 16-22 and 23-29. The younger population is not surprising mainly due to the fact that younger males and females are more prone to walking long distances and long time periods. For females; however, there seemed to be a peek at 44+. Maybe this range was a little to board, and could have had another interval after 44 years. Overall, the results of this age distribution were good because our product is aimed toward a younger to mid age population that walks a lot.

FIG M1.3-3

This chart is indeed unique. Where most female had a peek at a shoe size, males did not. This is mainly due to the fact that males have a larger show size than most women do. It seems as if the peeks for most females were at the shoe sizes between 7-9, while the peeks for most males were at the shoe sizes 9, 10, and 11. It is very surprising that the shoes sizes were at these peeks, yet the half-shoes such as 9.5, and 10.5 had very little responses. Clearly, the females shoe size distribution was between 6-11.5, while the males was 6-15+. Something also noteworthy was that there were no females that answered past 11.5 as their shoe size, while there were tons of males that did.

FIG M1.3-4

The responses in this distribution are also varied. It seems as if the males answered more often with lower numbers of shoes acquired than females. The male’s peeks seem to be at 2 and 3 pairs every year. While the females peeks seem to be at 2-5, and 9+. It is not at all surprising that the females had the most amounts of responses at 9+. This is because females own and buy a lot more shoes than males would be ever think about having. This is partly because males have limited types of shoes they can buy, while females have flip-flops. Gym shoes, high-heels, flats, snow boats, UGGS, etc.

FIG M1.3-5

Most females and males said that they have had gum gotten stuck to their shoes. This is great justification for our product in which it states that yes people do get gum stuck to their shoes. What also makes this wonderful information is that so little people out of all the survey takes said that they have never gotten gum stuck to their shoe.

FIG M1.3-6

Most females and males said that they believe that gum is a hassle to remove once it is stuck onto the shoe. This too serves as great justification that our problem is actually a problem in the American society. This is great justification for our product because it states that people do have a problem removing gum from their shoe, and need a product that will prevent the problem in the first place. What also makes this wonderful data is that so little people, out of all the survey takers, said that they don’t believe it is a hassle to remove. This question; however, relates to the other, in which if the person has never gotten gum stuck to their shoe, they must have answered “no it is not a problem to remove.” The other possibility of answering no was that they had have gum stuck to their shoe, and did not think it was a problem to remove.

FIG M1.3-7

Only by a little margin did both females and males answer that they would buy our product. Basically the distribution for both males and females seems to be even, if considered both ways. Even though this is not one of our best result charts, it still holds value in making our product look good. If all American companies could convince half the American public to buy their product they would be rich. When looking at it from that perspective, we got more than half to agree to buy our product, and that is amazing.

For our biggest piece of justification, we are employing the following three charts. Chart A shows the total female population surveyed of 194 women. As the pie chart displays, 90% of the women answered Yes to the question “Have you ever had gum stuck on the bottom of your shoe?” Chart B then takes the population of 175 women that answered Yes to the question and divides them by their response to the question, “Do you think it is a hassle removing gum that has been stuck to the bottom of the shoe?” as the pie chart displays, 96% answered yes, they think it is a hassle. Chart C then displays the responses to the question, “Would you buy our product?” taken from the population of women that have had gum stuck to the bottom of their shoe and think that it is a hassle removing it, therefore having a population of 101 women.

FIG M1.3-8

FIG M1.3-9

FIG M1.3-10

**APPENDIX 1-E Chicago Interview Results:**

1) Do you spend a lot of time walking in the city?

* Responder #1:yes
* Responder #2:no
* Responder $3:yes
* Responder #4: I do not spend a lot of time because I am mostly living in the suburbs. When I go to downtown I usually walk for 2 or 3 hours.

2) About how much? Daily? Hourly?

* Responder #1:half an hour
* Responder #2:half an hour
* Responder #3: one hour
* Responder #4: weekly- for 2 to 3 hours

3) Do you live in the city or commute here for work, school ,ect.?

* Responder #1:commute for work
* Responder #2:commute for work
* Responder #3:commute for shed
* Responder #4: I am living here in the suburbs, but I go there for college

4) Do you notice a lot of gum covering the sidewalks?

* Responder #1:yes
* Responder #2:yes
* Responder #3:yes
* Responder #4: Yes!! All the time! It is annoying!

5) If yes, do you try to avoid stepping on it?

* Responder #1:yes
* Responder #2:no
* Responder #3:yes
* Responder #4: I think I have? But if I did, it was bad!

6) Have you ever had gum stuck on the bottom of your shoe?

* Responder #1yes
* Responder #2: yes
* Responder #3:yes
* Responder #4: yes

7) Was it from walking in the city?

* Responder #1:yes
* Responder #2:no
* Responder #3:no
* Responder #4:yes

8) How frequently does this happen?

* Responder #1:monthly
* Responder #2:rarely
* Responder #3: rarely
* Responder #4: not that often

a. How did you remove the gum?

* Responder #1:napkin
* Responder #2: don’t
* Responder #3:scrape shoe against ground
* Responder #4: I think with paper towels? It was bad.

b. Or did you leave it there or dispose of the shoe?

* Responder #1:no
* Responder #2:yes
* Responder #3:no
* Responder #4: yes

9) Was it easy or time consuming to remove it?

* Responder #1: time consuming
* Responder #2: time consuming
* Responder #3: time consuming
* Responder #4: Very time consuming. I hate when people spit gum on the ground and we get stuck in it!!

10) What would you prefer it to be like, gum not stick to shoes at all, there not be any gum on the sidewalks or what?

* Responder #1:gum not stick to shoes
* Responder #2: not be any gum on the sidewalks
* Responder #3: not be any gum on the sidewalks
* Responder #4: I prefer the shoes one because a lot of people will still be disobedient to not throw gum on the ground. Shoes that have gum repellent on them would be better.

11) Do you know if there is anything being done to prevent gum from being disposed on the ground?

* Responder #1:no
* Responder #2:no
* Responder #3:no
* Responder #4: no

a. How about from sticking to shoes?

* Responder #1:no
* Responder #2:no
* Responder #3:no
* Responder #4: no

b. Do you think those products or processes are effective?

* Responder #1:nope
* Responder #2:nope
* Responder #3: nope
* Responder #4: nope

12) What if there was a product to apply to the bottom of the shoe to prevent gum from sticking? Do you think it would be worth your money and interest?

* Responder #1:yes
* Responder #2:no
* Responder #3:no
* Responder #4: maybe. I mean if there was a spray or something that I can just put on the bottom of my shoes then I would like it so that way with whatever shoes I wear I can just spray it on.

a. Do you know of any existing similar products like that?

* Responder #3: no
* Responder #3: no
* Responder #3: no
* Responder #3: no

**APPENDIX 3-A Slip Resistance Test**

*Purpose:* to test the product for safety in regards to slipperiness on different surfaces.

*Materials:*

-Tester shoe

-Product

-Testing pendulum

-Tile surface

-Grass patch

-Carpet patch

-Pavement block

*Procedure:*

1. Apply the product to the shoe.
2. Set up the pendulum on the tile surface.
3. Apply the shoe on the bottom of the arm.
4. Set the pendulum arm up at the top of the pendulum frame.
5. Release the arm.
6. Observe if the arm is stopped at the contact with the surface.
7. Set the arm up again at 1meter height.
8. Add enough water to cover the entire surface.
9. Release the arm.
10. Observe if the arm is stopped at the contact with the surface.
11. Repeat the steps 4-10 with the different surfaces.

*Data Results:*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Stopped or not | | | |
|  | With water | | No water | |
| Surface | Yes | No | Yes | No |
| Tile |  | X | X |  |
| Grass | X |  | X |  |
| Carpet | X |  | X |  |
| Pavement | X |  | X |  |

TAB M4.1-1

**APPENDIX 3-B Heat Resistance Test**

*Purpose:* to make sure the product behaves the same in environments of varying temperatures that it is likely to encounter. Test measures for change in size that may occur as the product is heated.

*Materials:*

* Product
* T-shirt dryer
* Heat sensor
* 3 sheets of paper
* Ruler
* Writing utensils

*Procedure:*

1. Obtain the materials.
2. Take the product and draw an outline of it on a piece of paper.
3. Use the ruler to measure the length of the traced product, and make three marks at of the length, points A, B and C respectively.
4. Measure the width of the product at the marked points, and record the values in the chart.
5. Turn on the t-shirt drier, set to 4th heat setting, and belt speed of 4.
6. Place the product on the belt and allow it to go through.
7. Use the heat sensor to observe the range of temperature the product goes through.
8. Once the product comes out the other side, place it on the back of the sheet of paper, and outline again.
9. Use the ruler to measure the length of the product, and make three marks at of the length.
10. Measure the width of the product at the marked points, and record the values in the chart.
11. Repeat steps 2-10 changing the heat setting in step 5 to 6th and 8th.

For a successful product, no changes in the product should occur within the test. The temperature range accounts for asphalt or sand in the summer it is known to reach temperatures up to 140 degrees Fahrenheit.

*Data Results:*

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Degrees (F) | Point A (cm)  Before After | | Point B (cm)  Before After | | Point C (cm)  Before After | | Length (cm)  Before After | |
| 140 | 9.5 | 9.5 | 7.5 | 7.5 | 6 | 6 | 26.5 | 26.5 |
| 170 | 9.5 | 9.5 | 7.5 | 7.5 | 6 | 6 | 26.5 | 26.5 |
| 200 | 9.5 | 9.5 | 7.5 | 7.5 | 6 | 6 | 26.5 | 26.5 |

TAB M4.1-2

**APPENDIX 3-C Flexibility Test**

*Purpose:* to test that the product has flexibility to ensure that the user experiences comfort when using the product.

*Materials:*

* Protractor
* Timer
* Ruler
* Marker
* Tester product

*Procedure:*

1. Use the ruler to measure the length of the product, and make three marks at of the length.
2. Set the product flat on a surface and place the protractor against it at the first mark.
3. Fold the product at the mark to 60 degrees, 120 degrees, and 180 degrees at 10 seconds each.
4. Observe if the product cracks, or disfigures; note the results in the chart.
5. Repeat step 3 for marks of the product.

*Data Results:*

|  |  |  |  |
| --- | --- | --- | --- |
|  | Observations | | |
| Degrees | 1/3 Mark | 1/2 Mark | 2/3 Mark |
| 60 | The fold did not produce any changes in the product | The fold did not produce any changes in the product | The fold did not produce any changes in the product |
| 120 | Returned to its normal shape; no changes | Returned to its normal shape; no changes | Returned to its normal shape; no changes |
| 180 | The product was slower to return to its normal shape, slight crease present, but there were no permanent changes | The product was slower to return to its normal shape, but there were no permanent changes | The product was slower to return to its normal shape, but there were no permanent changes |

TAB M4.1-3

**APPENDIX 3-D Water Absorption Test**

*Purpose:* To test whether or not our product absorbs water while submerged in it for different periods of time.

*Materials:*

* 4 tester products
* Room temperature water
* 15 quart container
* Towels/Napkins
* Timer
* Scale

*Procedure:*

1. Gather all lab materials.
2. Pour water into bucket and fill to about one inch of height.
3. Weigh the product.
4. Place the product into the bin and submerge in the water.
5. Wait 1 minute while letting the product soak in the water.
6. Remove the product after the 1minute and dump out any water inside. Wipe it down dry.
7. Measure the mass and note the difference.
8. Repeat steps 3-9 with new products changing the time the product is submerged in water from 1 minute to 5, 10, and 60 minutes.
9. Place all lab materials back.

\*Note: if the product absorbs water leaving insufficient amounts for the next test, it is necessary to fill the container again.

|  |  |  |
| --- | --- | --- |
| Time in water (min) | Starting Mass (g) | Ending Mass (g) |
| 1 | 29.0 | 29.0 |
| 5 | 28.9 | 28.9 |
| 10 | 29.1 | 29.1 |
| 60 | 29.0 | 29.0 |

*Data Results:*

TAB M4.1-4

**APPENDIX 3-E Multiple Surface Tests**

*Purpose:* to test how different surfaces will affect whether or not the gum sticks to the gum shield.

*Materials:*

* Tester product with shoe
* Orbit gum sticks
* 120-140 lb volunteer
* Surfaces
  + Concrete block
  + Carpet patch
  + Tile
  + Brick
  + Grass patch

*Procedure:*

1. Gather all lab materials.
2. Chew piece of gum for 5 minutes.
3. Place gum on concrete block.
4. Have a person put on the shoe with the product, leisurely walk, and step on the gum.
5. Note whether the gum stuck to the gum shield or not.
6. Repeat steps 2-5 with the other four surfaces.
7. Place all lab materials back.

*Data Results:*

|  |  |  |
| --- | --- | --- |
| Surface Type | Gum Stuck to Product  Yes No | |
| Concrete | X |  |
| Carpet | X |  |
| Tile | X |  |
| Brick | X |  |
| Grass | X |  |

TAB M4.1-5

**APPENDIX 3-F Stress Test**

*Purpose:* to observe how much force the product can withstand until it tears.

*Materials:*

-Structural stress analyzer

-Lab Structural stress analyzer

-Two replicas of the product

-Two metal plates

-Two screws and nuts

*Procedure:*

1. Attach a plate on each side of the product about 1 inch from the bottom and screw them together.
2. Secure the product in the stress analyzer machine so that the downward force is exerted on the full length of the product.
3. Place the chain around the two plates and secure it on the loop.
4. Close the lid, and start the machine.
5. Once the analysis stops and the maximum force is determined, remove the product from the machine.
6. Take the second replica of the product and place it into the lab structural analyzer. Attach the product between two plates and place screws on the plate so the product can rest on them and to make sure the two plates are connected.
7. Once the analysis stops and the maximum force is determined, remove the product from the machine.

*Data Results (Graph and Explanation):*

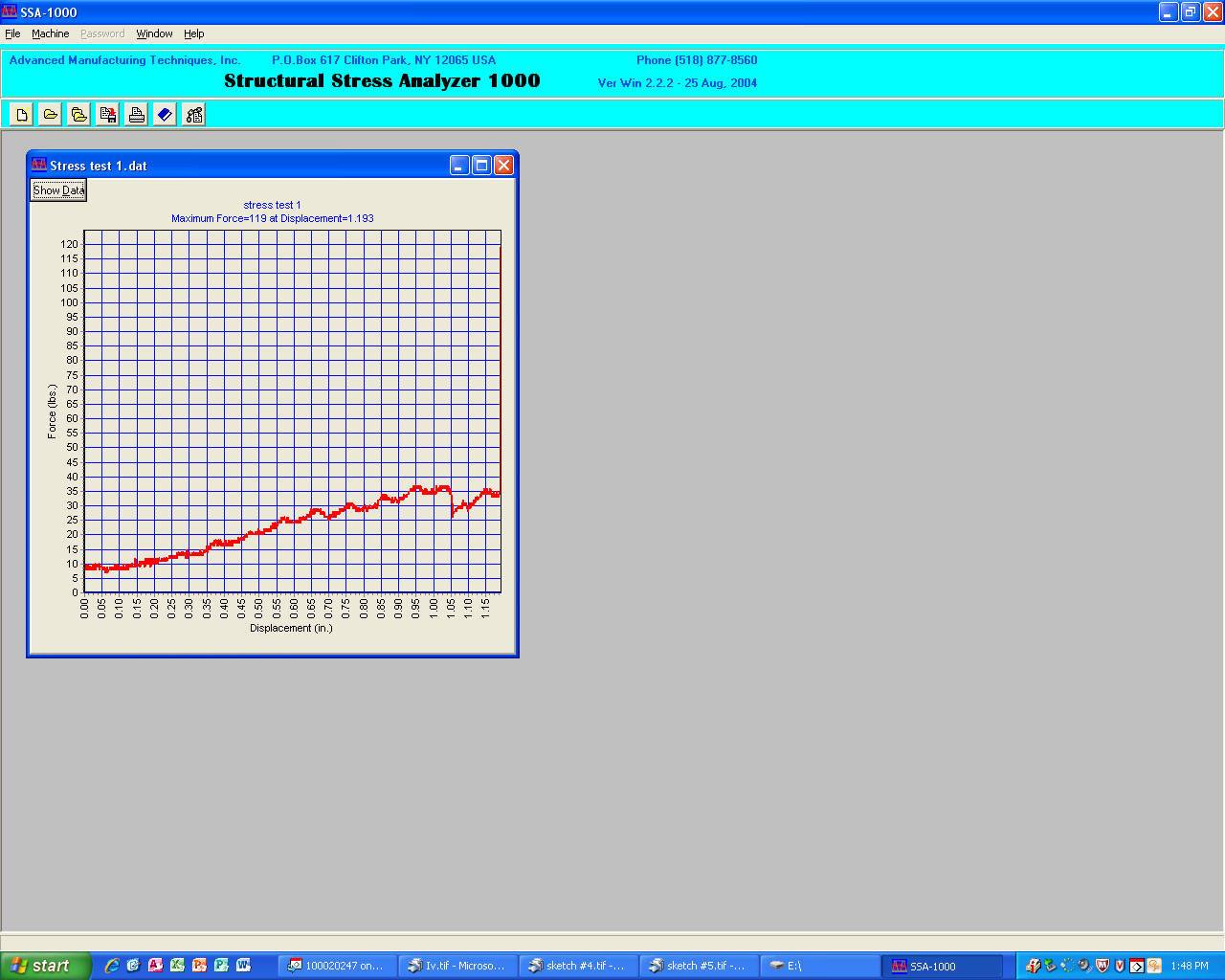


FIG M4.1-3

Neither the stress analyzer we created, nor the lab stress analyzer was able to break our product. The created machine could not go past 60 Newton, and our product went way beyond that as indicated by the lab stress analyzer graph (product goes to about 294 Newton before machines thinks it has broken it). This false “breaking” occurred three more times. However this does not matter because we know for a fact that the product will not be stretched more than 294 Newton to be placed on the product.

**LIST OF SYMBOLS, ABBREVIATIONS, ACRONYMS**

List of Symbols

%- percent

$- dollars

List of Abbreviations

inch-inches

min- minutes

g- grams

F- Fahrenheit degree

cm- centimeter

ft- feet

List of Acronyms

CAD- computer aided design